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Brief 70-10210

NASA TECH BRIEF

Oxidation Resistant Iron and Nickel Alloys for High Temperature Use

Iron-base alloys have been developed which have excellent oxidation resistance for extended periods of time at temperatures up to 2300°F, and also retain their ductility after exposure. The composition of these alloys, in weight percent, is essentially iron, 25 chromium, 4 aluminum, with small additions of yttrium and tantalum. The addition of yttrium in 0.08 to 0.27 weight percent provided excellent oxidation resistance during exposure to air at 2300°F for 800 hours. Typical results were 2 mils oxide penetration on either side of a 10-mil thick foil and less than 3.5 mg/cm^2 gain in weight. The addition of tantalum or hafnium as secondary modifier elements provided improved room temperature ductility (after exposure) and had no significant effect on oxidation resistance. One such alloy, composed of iron, 25 chromium, 4 aluminum, 0.08 yttrium and 0.5 tantalum, remained ductile after 800 hours exposure to air at 2300°F including 50 cycles to room temperature. The same iron-chromium-aluminum alloys with additions of thorium in the same atomic percentages as for yttrium also exhibited good oxidation resistance.

Nickel-base alloys were also investigated in the same program. Alloys composed essentially of nickel, 20 chromium, 5 aluminum, with small additions of yttrium or thorium exhibited considerable oxidation resistance. The best performing alloy of those tested was composed of nickel, 20 chromium, 5 aluminum, and 0.3 thorium. A 10-mil thick foil had a weight gain of 10 mg/cm^2 in 540 hours, and retained its ductility, but was oxidized internally throughout the foil thickness.

Notes:

1. These alloys can be used in applications where inexpensive highly oxidation-resistant materials are needed but high strength materials are not required. They can also be used in applications above the present operating temperatures of the super-alloys (now limited to 2000° to 2200°F with special coatings), and thoria-dispersed nickel (now limited by oxidation to 2000° to 2200°F), or they may be used as cladding for these materials.
2. The observed beneficial effects provided by the additions of yttrium, tantalum (or hafnium) and thorium might be applied to improve conventional iron-chromium-aluminum alloys such as those used in electrical resistance elements.
3. The following documentation may be obtained from:

   Clearinghouse for Federal Scientific and Technical Information
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.65)

   Reference:
   NASA-CR-72522 (N69-27775), Development of Ductile Claddings for Dispersion Strengthened Nickel-Base Alloys
4. Technical questions may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B70-10210

(continued overleaf)

Patent status:

No patent action is contemplated by NASA.

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